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Does Intelligence Affect Economic Diversification ?

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Abstract

This paper extends the growing literature on knowledge economy by investigating the effect of intelligence on economic diversification. Using a battery of estimation techniques that are robust to endogeneity, we find that human capital has positive effects on export diversification, manufactured added value and export manufactures. This empirical evidence is based on a world sample for the period 2010. The findings have significant implications for the fight against the Dutch disease. In essence, investing in human capital could bring economic diversity and therefore dampen negative external shocks related to resource-dependence. Other knowledge-economy implications are discussed, notably: the need to boost college enrolment and research & development on the one hand; and the imperative for workers to adapt to challenging and changing conditions of technology within a lifelong learning policy framework.

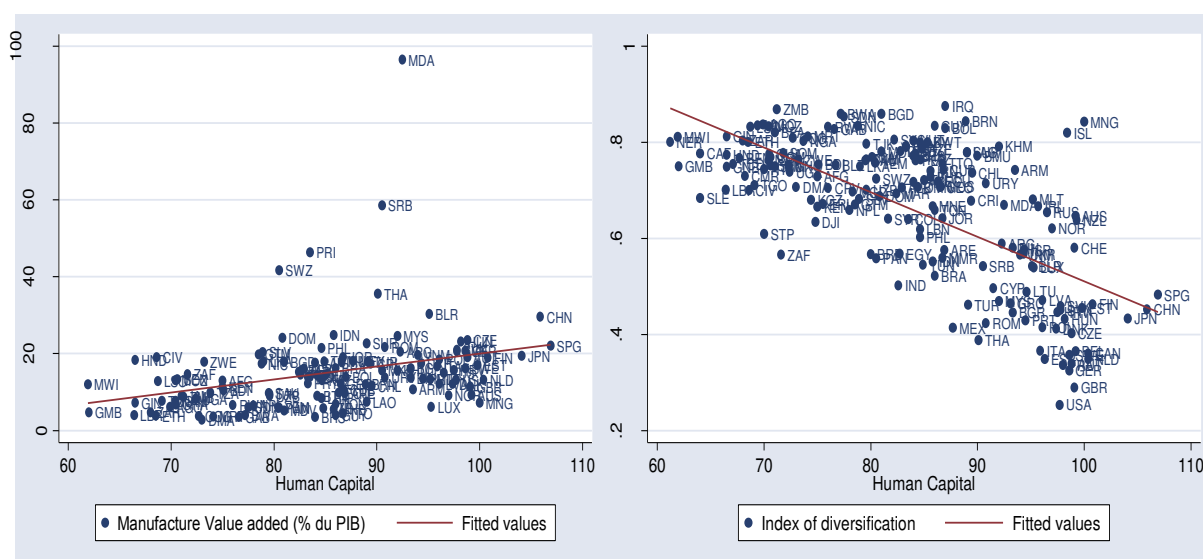
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1. Introduction

Can human capital affect economic diversification? Most empirical studies have engaged human capital as a control variable in regressions without going further (Hausman et al., 2007; Weldemicael, 2012). Hence, human capital is relegated to the second rank. In one of the cited studies, Hausmann et al. (2007) acknowledge, inter alia, that the link between diversification and human capital is bidirectional. Figure 1 below illustrates this acknowledgement as it is difficult to discern the potential endogeneity.

Figure 1. Human Capital and Economic diversification



As far as we are concerned, the consideration of human capital in a plethora of regressions implies that this underlying variable is useful in economic diversification. In the present exposition, we consider this indicator as an independent variable of interest. Moreover, we are convinced human capital is very useful when considered in an economic structure. Hence, economic sectors should be attracted by more qualified human capital. This could be the basis for labour reallocations from the agricultural to more productive sectors. Externalities resulting from human capital accumulation could result from low economic diversification. Accordingly, an economy that is highly focused on a certain brand reduces interaction among persons and hence increases competition, which could eventually discourage cooperation. Conversely, increasing human capital remains essential for economic sophistication.

As far as we have reviewed, Parketa & Tamberi (2008) and Gullstrand (2008) are some of the few theoretical studies linking human capital to economic diversification. The first-two authors articulate that more human capital facilitates production diversification and hence, increase the rate of new activities in an economy, notably due to product innovation. Gullstrand thinks it enables the differentiations within the framework of intra-industrial commercial models.

Another contribution of the present study is to seriously investigate the issue of endogeneity by taking into account instrumental variables. This provides a more informed opinion on the relationship between the two underlying variables. This knowledge is quite relevant in complementing the literature given the substantial bulk of studies on the importance of diversification in economic development (Piñeres & Ferrantino, 1997 ; Feenstra et al., 1999; Al-Marhubi, 2000; Funke & Ruhwedel, 2005; Herzer & Nowak-Lehmann, 200; Hausmann et al., 2007; Hess, 2008; Jarreau & Poncet, 2012).

The third contribution of the current exposition to the literature is the measurement of human capital. Economists have traditionally appreciated human capital using quantitative measures and qualitative educational indicators, with the former more exploited (Lutz, 2009). The traditional indicators are predominantly used in growth regressions, inter alia: average years of schooling, life expectancy at school, gross schooling rate in the primary, secondary and tertiary schools (see Barro, 1991; Benhabib & Spiegel, 1994; Barro & Lee, 1993, 2001; Caselli et al., 1996; Mankiw et al., 1992 ; Levine & Renelt, 1992; Sala-i-Martin et al., 2004). The effects of these indicators have not yielded a consensus because of data measurement issues (Cohen & Soto, 2007; De la Fuente & Doménech, 2006). Notably, Weede & Kämpf (2002) have criticised the neglect of output in these human capital indicators, which essentially relies on inputs. This has led to some authors using international academic evaluation tests, notably: Trends in International Mathematics and Science Study (TIMSS) and the Program of International Student Assessment (PISA) (Hanushek & Kimko, 2000; Hanushek & Woessmann, 2008, 2009).

Another strand of authors including the psychologist and Vanhanen (2001,2002, 2006) has compiled data on intellectual quotient (IQ) from many countries. This data has led to many published studies (Lynn & Vanhanen, 2012b). This data is also increasingly being employed by economists (Weede & Kämpf, 2002; Jones & Schneider, 2006; Ram, 2007; Potrafke, 2012; Kodila-Tedika & Kanyama-Kalonda, 2014; Kodila-Tedika, 2014; Rindermann et al., 2014; Kodila-Tedika & Mustacu, 2014; Kodila-Tedika & Bolito-Losembe,

2014). The stream of data from Hanushek and, Lynn & Vanhelen is increasingly being improved and has recently been improved (Rindermann, 2007a, b; Meisenberg & Lynn, 2011). Meisenberg & Lynn, (2012) and Kanyama-Kalonda (2014) have recently employed this new stream of data. In the present study, we also borrow from this new stream.

From cross-sectional data on a number of countries, we establish a weak correlation between economic diversification and human capital. This correlation is generally robust to outliers, a plethora of estimation techniques as well as the inclusion of control variables. We have also considered the hypothesis of causality flowing from human capital to economic diversification. Our estimations suggest a positive effect of this capital on diversification. Hence, more human capital engenders greater economic diversification. This conclusion contributes to the literature on economic diversification in the areas already discussed above.

The rest of the paper is structured as follows. Section 2 discusses the methodology while Section 3 focuses on the data. The main results are presented in Section 4 whereas Section 5 concludes.

2. An Empirical Model Linking Economic Diversification to Human Capital

The main hypothesis of this investigation sustains that Human Capital (HC) has a significant and positive impact on Economic Diversification (EC). As a primary first-step, we estimate the following basic empirical model:

$$ED_i = \beta_0 + \beta_1 HC_i + \delta Z_i + \varepsilon_i, \quad (1)$$

where ED is economic diversification, HC denotes the human capital, $i=1,2,\dots$ captures the country index, $Z = (z_1, \dots, z_k)$ is the vector of control variables, and ε_i represents the error term that is assumed to be normally and independently distributed. β_0 is the intercept, β_1 captures the effect of human capital and $\delta = (\delta_1, \delta_2, \dots, \delta_n)$ is the parameter denoting the vector for control variables. The control variables used are consistent with those employed by Hausmann et al. (2007). The model is estimated using Ordinary Least Squares (OLS) that are robust to standard errors. As emphasized by Hausmann et al. (2007), if $E(\varepsilon|HC) = E(\varepsilon) \neq 0$ is the cause of the endogeneity and hence, reverse causality, ED should be regressed with only the exogenous component of HC in order to correct the bias in endogeneity.

The endogeneity issue is corrected by employing a Two-stage-least squares (2SLS) estimation technique. In the first-stage, we regress the endogenous component of HC in an OLS equation as follows:

$$HC_i = \varphi_0 + \varphi_1 N_i + \delta Z_i + \varepsilon_i, \quad (2)$$

This enables us to extract the exogenous component of HC predicted by, \hat{N}_i :

$$\widehat{HC}_i = \widehat{\varphi}_0 + \widehat{\varphi}_1 \hat{N}_i + \delta Z_i + \varepsilon_i, \quad (3)$$

In the second-stage of the regression, we insert the fitted values from Eq. (3) into Eq. (1). Hence, we replace HC with \widehat{HC} in Eq. (1), to obtain the following OLS equation:

$$ED_i = \omega_0 + \omega_1 \widehat{HC}_i + \delta Z_i + \varepsilon_i, \quad (4)$$

The concern arising from Eq. (4) is to investigate if the fitted values are good instruments for human capital. This issue is handled by an overidentification restrictions test in the empirical section of the paper. Moreover, to ensure robustness we shall employ at least two instruments to mitigate the endogeneity concern.

3. Data

We examine a world sample ofcountries for the period 2010. The concept of diversification is employed to emphasise the development of the productive industry which improves the economic structure towards modern economic activities. It is also the source of positive externalities for other sectors. Hence, this concept underlines export diversification. Accordingly, we measure economic diversification with the annual comparative diversification index of export and import of commodities (CNUCED, UNCTADstat). Low values of this variable denote high levels of diversification in a given country. We therefore expect the human capital variable to have a negative effect on this dependent variable. This is contrary to what we expect of two other variables. Our second variable is the added value of the manufacturing sector to GDP from World Development Indicators (WDI) of the World Bank (WB). The third indicator that we employ to measure economic diversification is a binary variable, taking the values of 1 if the country is a major exporter. Major export category: substantial exports are those that account for 50 percent or more of total exports of goods and services from one category. The categories are: nonfuel primary (SITC 0,1,2,4, plus 68), fuels (SITC 3), manufactures (SITC 5 to 9, less 68), and services (factor and

nonfactor service receipts plus workers' remittances). If no single category accounts for 50 percent or more of total exports, the economy is classified as diversified. This measurement is consistent with Easterly & Sewadej (2001).

The data on intelligence is from Meisenberg & Lynn (2011) -previous versions with this dataset can be found in Lynn & Vanhanen (2002, 2006). This dataset is a compilation of hundreds of average national IQ tests observed over the 20th and 21st centuries using best practice methods. Average IQ is a measure of general-purpose human capital as well as a measure of the nation's labor quality (Hanushek & Kimko, 2000; Jones & Schneider, 2006). With regard to institutional quality, we consider IQ as a measure of the ability of a nation's human capital to cooperate in order to produce a nationally efficient outcome in terms of pro-market policies. The advantage of the recent dataset is that it includes more countries as well as a composite measure of intelligence in the form of human capital.

Three measures of intelligence are considered: the IQ measure from Lynn & Vanhanen, a measure where the missing values are filled with school achievement, and a measure of human capital which is a composite measure that accounts for IQ and school achievement. However, since the first measure is a subset of the second, we shall only use the second and the third measures in our analysis.

The measures of institutional quality are obtained from the dataset compiled by Daniel Kaufmann, and Art Kraay and Massimo Mastruzzi at the World Bank (www.govindicators.org). This dataset aggregates indicators of six broad dimensions of governance: voice & accountability, political stability & absence of violence/terrorism, government effectiveness, regulatory quality, rule of law and control of corruption. The six aggregate indicators are based on 30 underlying data sources reporting the perceptions of governance from a large number of survey respondents and expert assessments worldwide. We use only rule of law.

The data on GDP per capita and openness are obtained from Pen World Tables, the 7.1 version. The relevance of the GDP per capita (Imbs & Wacziarg, 2003; De Benedictis et al., 2009; Parteka, 2007; Cadot et al., 2007) and openness indicators have been substantially documented in the literature (Krugman & Venables 1990; Costas et al. 2008).

The data on population and area is from the WDI of World Bank. The works of Hummels & Klenow (2005) and Parteka & Tamberi (2008) have clearly articulated the important role of economic size in economic diversification. Population size here is considered as a measure of this market size. Given that geographic elements (Radelet &

Sachs, 1998; Limão & Venables, 2001) can also influence the dependent variable; we have considered the effect of *Area* in the analysis.

Table 1 below which presents the summary statistics of the variables used in the study has a twofold interest. On the one hand, it reveals that the variables are quite comparable. On the other hand, the variations are quite substantial. Hence, we can be confident that some reasonably significant nexuses should emerge from the estimations.

Table 1: Summary Statistics

| Variables | Obs | Mean | Std. Dev. | Min | Max |
|----------------------------------|-----|--------|-----------|--------|---------|
| Index of diversification | 182 | .66 | .15 | .25 | .88 |
| Manufacture – value added (%GDP) | 139 | 14.64 | 11.17 | 2.12 | 96.58 |
| Exports of manufactures | 139 | .17 | .38 | 0 | 1 |
| Human capital | 175 | 84.21 | 10.85 | 61.2 | 106.9 |
| Open | 140 | 95.42 | 57.16 | 26.65 | 446.06 |
| GDP per capita (log) | 140 | 8.873 | 1.19 | 5.90 | 11.17 |
| Rule of law | 139 | .013 | .99 | -1.75 | 1.95 |
| Population | 123 | 16.53 | 63.11 | -13.54 | 612.36 |
| Area | 123 | 381.13 | 1020.2 | .122 | 8600.39 |

Obs : Observations. Std. Dev: Standard Deviation. Min: Minimum. Max: Maximum.

4. Empirical results

4.1 Main results

The main result are based on OLS and Probit estimators that are robust to White's (1980) heteroskedasticity correction, are presented in Table 2 below. The following conclusions are established. First, when the dependent variable is the index of diversification, while *Area* and *Openness* decrease economic diversification, the other variables have the opposite effect, notably: *human capital*, *GDP per capita*, *rule of law* and *population*. Second, when economic diversification is either measured by *Manufacture value* or *Exporters of manufactures added value*, human capital increases economic diversification, consistent with the predictions of economic theory. With the exception of the rule of law which consistently increases economic diversification across all specifications (with the alternative dependent variables), the other control variables for second and third dependent variables consistently display opposite signs. This opposition in signs is expected because one of the dependent variables (or diversification index) is appreciated in decreasing order, such that higher values denote low diversification and vice-versa.

Table 2. Main regressions

| | Index of diversification | Index of diversification | Manufacture – value added | Manufacture – value added | Exporters of manufactures | Exporters of manufactures |
|-----------------------|-----------------------------|-----------------------------|---------------------------------|---------------------------------|------------------------------|------------------------------|
| Human capital | -.0092695 (0.000) | -.0063527 (0.007) | .3377822 (0.000) | .3047204 (0.018) | .095458 (0.000) | .2330314 (0.000) |
| Open | | .0003624 (0.186) | | -.0094717 (0.626) | | -.0002127 (0.941) |
| GDP per capita (log) | | -.0197179 (0.355) | | .7594738 (0.569) | | .5368238 (0.281) |
| Rule of law | | -.0287762 (0.137) | | -2.205784 (0.031) | | -.9128011 (0.037) |
| Population | | -.0003563 (0.091) | | .0219769 (0.000) | | .0001544 (0.971) |
| Area | | 7.83e-06 (0.505) | | -.0012411 (0.002) | | -.000017 (0.910) |
| Adj R ² | 0.4356 | 0.4948 | 0.0972 | 0.1951 | | |
| Pseudo R ² | | | | | 0.3015 | 0.4833 |
| Obs | 170 | 112 | 125 | 83 | 173 | 115 |
| Method | OLS | OLS | OLS | OLS | Probit | Probit |

Notes: For OLS regressions, the heteroscedasticity correction is consistent with White. Constants are included in all regressions. P-values in brackets.

4..2 Robustness checks

4.2.1 Additional variables and fixed effects

In this section, three more control variables are added to verify the solidity of estimations in Table 2. In Table 3, additional continental clusters and more control variables are used. The additional control variables include: a dummy variable for the Organisation for Economic Co-operation and Development (OECD) membership, corruption from WDI and shadow economy from Schneider et al. (2010). The effects of human capital on the dependent variables are significant for the most part across specifications and broadly consistent with those of Table 3.

Table 3. Additional variable and clusters

| | Index of diversification | Manufacture – value added | Exporters of manufactures | Index of diversification | Manufacture – value added | Exporters of manufactures |
|-------------------------|-----------------------------|---------------------------------|------------------------------|-----------------------------|---------------------------------|------------------------------|
| Human capital | -.0040273 (0.069) | .3038859 (0.019) | .3128218 (0.002) | -.0036186 (0.241) | .2555926 (0.044) | .3124921 (0.000) |
| Control Variables | Yes | Yes | Yes | Yes | Yes | Yes |
| Additional variables | Yes | Yes | Yes | Yes | Yes | Yes |
| Cluster of continent | No | No | No | Yes | Yes | Yes |
| Adj R ² | 0.5806 | 0.2228 | | 0.6187 | 0.3409 | |
| Pseudo R ² | | | 0.5077 | | | 0.5010 |
| Observations | 109 | 81 | 112 | | 79 | 108 |
| Method | OLS | OLS | Probit | OLS | OLS | Probit |

Notes: For OLS regressions, the heteroscedasticity correction is consistent with White. Constants are included in all regressions. P-values in brackets

In Table 4 below, we use regional dummy variables for Sub-Saharan Africa (SSA), the Middle East & North Africa (MENA), Latin America & the Caribbean, East Asia & the Pacific, East Europe and Central Asia. The signs of the independent variables of interest are consistent with those in Tables 2-3.

Table 4. Using regional dummies

| | Index of diversification | Manufacture – value added | Exporters of manufactures |
|-----------------------|-----------------------------|------------------------------|------------------------------|
| Human capital | -.0050032 (0.040) | .065878 (0.618) | .2854369 (0.004) |
| Variables controls | Yes | Yes | Yes |
| Dummy régional | Yes | Yes | Yes |
| Adj R ² | 0.50 | 0.2762 | |
| Pseudo R ² | | | 0.3778 |
| Observations | 111 | 82 | 52 |
| Method | OLS | OLS | Probit |

Note: For OLS regressions, the heteroscedasticity correction is consistent with White. Constants are included in all regressions. P-values in brackets

4.2.2 Outlier variables

In order to further improve the estimations, our empirical approach follows the M-estimators of Huber (1973) by using iteratively reweighted least squares (IRWLS) and MM-estimator proposed by Yohai (1987). As Midi & Talib (2008) have noted, compared to the OLS approach, the advantage of these robust estimators is that they fix simultaneously any issue arising from the existence of outliers and/or heteroskedasticity (non-constant error variances). As far as we know, these regression techniques are not currently available for logistic specifications. Hence, our third dependent variable is not used. We find that the signs

and significance of the variables across specifications are consistent with those of the preceding tables.

Table 5. Controlling for Outliers

| | Index of diversification | Index of diversification | Index of diversification | Manufacture – value added | Manufacture – value added | Manufacture – value added |
|----------------------|-----------------------------|-----------------------------|-----------------------------|---------------------------------|---------------------------------|---------------------------------|
| Human capital | -.0069176 (0.001) | -.006696 (0.011) | -.0059551 (0.029) | .2900485 (0.008) | .2893021 (0.048) | .2912232 (0.115) |
| Open | .0003185 (0.270) | .0003909 (0.175) | .0002443 (0.367) | -.0159217 (0.304) | -.0144367 (0.462) | -.0200911 (0.476) |
| GDP per capita (log) | -.01744 (0.391) | -.0165569 (0.482) | -.0206065 (0.393) | .8489403 (0.456) | .8914394 (0.569) | .8822282 (0.652) |
| Rule of law | -.028652 (0.173) | -.0328507 (0.115) | -.0276166 (0.172) | -2.163248 (0.061) | -2.20712 (0.030) | -2.189618 (0.059) |
| Population | -.0010804 (0.009) | -.0003322 (0.098) | -.0049103 (0.000) | .0210193 (0.051) | .0217959 (0.000) | .0203297 (0.004) |
| Area | .000018 (0.198) | 8.52e-06 (0.503) | .0000847 (0.000) | -.0012104 (0.091) | -.0012466 (0.002) | -.001209 (0.004) |
| Obs | 112 | 112 | 112 | 83 | 83 | 83 |
| Method | IRWLS | M-estimators | MM-estimator | IRWLS | M-estimators | MM-estimator |

Notes: Constants are included in all regressions. P-values in brackets

4.2.3. Endogeneity test

In order to control for endogeneity, we employ instruments of protein and fats per capita daily macronutrients for 2005–2007 (FAO¹ Statistics Division, 2010), human capital accumulation in the early twentieth century and Historic IQ (Lynn, 2012). Data on students enrolled in primary and secondary schools in the early twentieth century is from Mitchell (2003a, b, c). The first-two instruments are exploited in the first column whereas the first and third are exploited in the other two columns. The sign of the main independent variables remains unchanged while most of the significant control variables have the expected signs.

¹ Food and Agricultural Organisation.

Table 6. Controlling for endogeneity

| | Index of diversification | Manufacture – value added | Exporters of manufactures |
|----------------------|-------------------------------------|--------------------------------------|--------------------------------------|
| Human capital | -.0259793 (0.001) | .350933 (0.038) | .2126032 (0.001) |
| Open | .0002751 (0.621) | .0034992 (0.881) | .0004657 (0.928) |
| GDP per capita (log) | .1051149 (0.076) | .769525 (0.660) | .2833632 (0.622) |
| Rule of law | .0111592 (0.718) | -2.414453 (0.015) | -.7620715 (0.087) |
| Population | .0003614 (0.334) | .0207795 (0.004) | -.0012882 (0.575) |
| Area | .0000194 (0.467) | -.0012606 (0.002) | .000026 (0.872) |
| Adj R ² | 0.1644 | 0.2122 | |
| Observations | 91 | 72 | 95 |
| Method | 2SLS | 2SLS | Probit IV |
| Test de Sargan | 0.4738 | 0.3924 | |
| Test de Hausmann | 0.4926 | 0.4177 | |
| Wald chi2 | | | 31.94 |
| Wald test | | | 0.1336 |

Notes: Constants are included in all regressions. P-values in brackets. 2SLS: Two-Stage-Least Squares. IV: Instrumental Variable.

The main policy implication is centred on the positive effect of human capital on: export diversification, manufactured added value and export manufactures. Hence, this has a potential to mitigate the Dutch disease in resource-dependent countries. In essence, investing in human capital (especially in least developed countries) would bring economic diversity and therefore dampen negative external shocks related to resource-dependence. As recently shown by Tchamyou (2014) and Asongu (2014ab), South Korea's economic miracle substantially depended on the enhancing of human capital. Two important points emerge here: the need to boost college enrolment and research & development (R&D) on the one hand; and the imperative for workers to adapt to challenging and changing conditions of technology.

First, countries need to adopt very bold moves towards increasing school enrolment rates and allocating more budgets to R&D. Such measures should be implemented hand-in-glove with improvements in other areas like policy and institutional environments. These include, inter alia: capacity building and independence of government agencies. It is expected that education should enhance a country's possibilities of acquiring knowledge, novel know-how and technological abilities. This combination of policies would produce and strengthened blocks is learning activities, human resource development and economic diversification (Suh & Chen, 2007; Lee, 2009; Tchamyou, 2014; Asongu, 2014a).

Second, the policy of education needs to be one of lifelong-learning and should be fully implemented in the workplace to enhance adaptation to changing and evolving

technology. Moreover, technical apprenticeship and vocational trainings would substantially boost the possibilities for economic diversification. Continuous trainings at work places should also be encouraged. Nurturing of high calibre engineers and scientists capable of analysing the needs for economic diversification and adapting know-how to existing challenges is crucial for competitive advantage in the global economic environment. This is also true because, as nations grow, technological competence becomes critical to sustaining growth and development. In order to continuously exploit economic diversification opportunities on the boundaries of science and technologies, knowledge-economy based policies should be fundamental to economic policy. As shown by Such & Chen (2007), when educational and industrialisation policies converge within a single strategic umbrella, the effects in enhancing and sustaining development are substantial. Accordingly, education would produce technology-base learning and industrialisation that have positive effects on economic diversification. On the other hand, accelerating industrialisation and economic diversification would promote the demand for more skills. This policy is consistent with the findings of Tchamyu (2014) who has recently established the positive effect of knowledge economy on doing business.

In summary, a knowledge-oriented industrial policy is substantially different from the traditional industrial policy on many fronts (factor inputs; output versus (vs) systematic interactions; firms & industries vs Networks & systematic linkages....etc). Policy options in knowledge-economy diversification strategies on which this study could be extended have been documented by Dobrinsky (2008).

Concluding

This paper has extended the growing literature on knowledge economy by investigating the effect of intelligence on economic diversification. Using a battery of estimation techniques that are robust to endogeneity, we have found that human capital has positive effects on export diversification, manufactured added value and export manufactures. This empirical evidence is based on a world sample for the period 2010. The findings have significant implications for the fight against the Dutch disease. In essence, investing in human capital could bring economic diversity and therefore dampen negative external shocks related to resource-dependence. Other knowledge-economy implications have been discussed, notably: the need to boost college enrolment and research & development on the one hand; and the

imperative for workers to adapt to challenging and changing conditions of technology within a lifelong learning policy framework.

References

- Al-marhubi, F. (2000). "Export diversification and growth: an empirical investigation". *Applied economics letters*, 7(9): 559–562.
- Asongu, S. A., (2014a). "Knowledge Economy Gaps, Policy Syndromes and Catch-Up Strategies: Fresh South Korean Lessons to Africa", *African Governance and Development Institute Working paper*, No. 14/014.
- Asongu, S. A., (2014b). "Software piracy and scientific publications: knowledge economy evidence from Africa", *Africa Development Review*: Forthcoming.
- Barro, R., 1991. Economic Growth in a Cross-Section of Countries. *Quarterly Journal of Economics* 106, 407–443.
- Benhabib, J. and Spiegel, M. 1994. The Role of Human Capital in Economic Development: Evidence from Aggregate Cross-Country Data. *Journal of Monetary Economics* 34, 143–173.
- Cadot, O., Carrère, C. and Strauss-Kahn, V. (2007). "Export diversification: what's behind the hump?". Centre for Economic Policy Research Discussion Paper, No. 6590.
- Caselli, F., Ciccone, A. (2013), The Contribution of Schooling in Development Accounting: Results from a Nonparametric UpperBound, *Journal of Development Economics*, 1-13, <http://dx.doi.org/10.1016/j.jdeveco.2013.02.006>
- Caselli, Francesco, Esquivel, Gerardo, Lefort, Fernando, 1996. Reopening the Convergence Debate: a New Look at Cross-Country Growth Empirics. *Journal of Economic Growth* 3, 363–389.
- Cohen, D. & Soto, M. (2007) Growth and Human Capital: Good Data, Good Results. *Journal of Economic Growth* 12: 51-76.
- Costas, A., Demidova, S., Klenow, P. and Rodriguez-Clare, A. (2008). "Endogenous variety and the gains from trade". *American Economic Review Papers and Proceedings*, 98(2): 444–450.
- De Benedictis, L., Gallegati, M. and Tamberi, M. (2009). "Overall specialisation and development: countries diversify". *The Review of World Economics*, 145(1): 37–55.
- De la Fuente, A. & Doménech, R. (2006) Human Capital in Growth Regressions: How Much Difference Does Data Quality Make? *Journal of the European Economic Association* 4: 1-36.
- Easterly, W and Sewadeh, M. (2001), Global Development Network Growth Database (GDN)
- Dobrinisky, R., (2008). "Knowledge-Oriented Diversification Strategies: Policy Options for Transition Economies", UN Commission for Europe, http://www.un.org/en/development/desa/policy/publications/general_assembly/eitconference/4aprpm_dobrinisky.pdf (Accessed: 18/10/2014).
- FAO Statistics Division (2010). *Food Balance Sheets*. Rome, Italy: Food and Agriculture Organization of the United Nations.
- Feenstra, R., Madani, D., Yang, T. and Liang, C. (1999). "Testing endogenous growth in South Korea and Taiwan", *Journal of Development Economics*, 60(2): 317–341.
- Funke, M., and Ruhwedel R. (2005). "Export variety and economic growth in East European transition economies". *Economics of Transition*, 13 (1): 25–50.
- Gullstrand, J. (2000). Country-Specific Determinants of Vertical Intra-Industry Trade With Application to Trade Between Poland and EU, [in:] B. Wawrzynjak (Ed.), *Globalisation and Change – Ways to Future*, Leon Kozminski Academy of Entrepreneurship and Management, Warsaw.
- Hanushek, E. A. & Woessmann, L. (2008). The Role of Cognitive Skills in Economic Development. *Journal of Economic Literature*, 46(3), 607-668.
- Hanushek, E. A., & Kimko, D. D. (2000). Schooling, Labor-Force Quality, and the Growth of Nations. *American Economic Review*, 90, 1184-1208.

- Hanushek, E.A. & Woessmann, L. (2009) Do better schools lead to more growth? Cognitive skills, economic outcomes, and causation. IZA Discussion Papers No. 4575
- Hausmann, R., Hwang, J. and Rodrik, D. 2007. What you export matters. *Journal of Economic Growth* 12 (1), 1–25.
- Herzer, D. and Nowak-Lehmann, F. (2006). “What does export diversification do for growth? An Econometric Analysis”. *Applied Economics*, Vol. 38 (15), S. 1825–1838.
- Hess, H. 2008. “Export Diversification and Growth” Working Paper No. 21, Growth Commission, World Bank, Washington DC.
- Huber, P.J. (1973). Robust Regression: Asymptotics, Conjectures and Monte Carlo, *The Annals of Statistics*, 1: 799–821.
- Hummels, D. and Klenow, P. (2005). “The variety and quality of a nation’s exports”. *The American Economic Review* 95(3): 704–723.
- Imbs, J. and Wacziarg, R. (2003). “Stages of diversification,” *American Economic Review*, 93(1): 63–86.
- Jarreau, J., Poncet, S. 2012. Export sophistication and economic growth: evidence from China. *Journal of Development Economics* 97 (2), 281–292.
- Jones, G. & Schneider, W. J. (2006). Intelligence, human capital, and economic growth: A Bayesian Averaging of Classical Estimates (BACE) approach. *Journal of Economic Growth*, 11, 71–93.
- Kalonda-Kanyama I, Kodila-Tedika O (2012). Quality of Institutions: Does Intelligence Matter?, Working Papers 308. Economic Research Southern Africa.
- Kodila-Tedika and Cinyabuguma, M. 2014. HIV/AIDS, Intelligence and Human Capital : Exploration New, mimeo.
- Kodila-Tedika, 2014, Governance and Intelligence: Empirical Analysis from African Data, forthcoming in the Journal of African Development
- Kodila-Tedika, O. and Bolito-Losembe, R. 2014, Poverty and Intelligence: Evidence Using Quantile Regression, *Economic Research Guardian*, (1): 25–32.
- Kodila-Tedika, Oasis & Mutascu, Mihai, 2014. “Tax Revenues and Intelligence: A Cross-Sectional Evidence,” MPRA Paper 57581, University Library of Munich, Germany.
- Krueger, Alan, Lindhal, Mikael, 2001. Education for growth: why and for whom? *Journal of Economic Literature* XXXIX, 1101–1136.
- Krugman, P. (1981). Intraindustry specialisation and the gains from trade. *The Journal of Political Economy*, 89(5): 959–973.
- Krugman, P. and Venables, A. (1990). Integration and the competitiveness of peripheral industry. [in:] Bliss C. and J. Braga de Macedo (Eds.). *Unity with diversity in the European economy: the Community's southern frontier*. Cambridge University Press, Cambridge.
- Lee, K., (2009), “How Can Korea be a Role Model for Catch-up Development? A ‘Capability- based’ View”, *UN-WIDER Research Paper* No. 2009/34.
- Levine, R. & Renelt, D. (1992) A sensitivity analysis of cross-country growth regressions. *American Economic Review* 82: 942–963.
- Limão, N. and Venables, A. (2001). “Infrastructure, geographical distance, transport costs and trade”. *World Bank economic review*, 15(3): 451–479.
- Lutz, W. (2009) Sola schola et sanitare: human capital as the root cause and priority for international development? *Philosophical Transactions of the Royal Society B* 364: 3031–3047
- Lynn, R. & Vanhanen, T. (2001) National IQ and economic development: a study of eighty-one nations. *Mankind Quarterly* 41: 415–435.
- Lynn, R. & Vanhanen, T. (2002) *IQ and the Wealth of Nations*. Westport CT: Praeger.
- Lynn, R. & Vanhanen, T. (2006) *IQ and Global Inequality*. Augusta GA: Washington Summit.
- Lynn, R. & Vanhanen, T. (2012a) *Intelligence. A Unifying Construct for the Social Sciences*. London: Ulster Institute.
- Lynn, R. (2012), IQs predict differences in the technological development of nations from 1000 BC through 2000 AD, *Intelligence* 40 (2012) 439–444.
- Lynn, R., & Vanhanen, T. (2012b). National IQs: A review of their educational, cognitive, economic, political, demographic, sociological, epidemiological, geographic and climatic correlates. *Intelligence*, <http://dx.doi.org/10.1016/j.intell.2011.11.004>.

- Mankiw, Gregory, Romer, David, Weil, David, 1992. A contribution to the empirics of growth. *Quarterly Journal of Economics* 107, 407–437.
- Meisenberg, G. & Lynn, R. (2011). Intelligence: A measure of human capital in nations. *Journal of Social, Political and Economic Studies*, 36(4), 421-454.
- Meisenberg, G. & Lynn, R. (2012). Cognitive Human Capital and Economic Growth: Defining the Causal Paths. *Journal of Social, Political and Economic Studies*, 37(4), 141-179.
- Midi, H. and Talib, B.A. (2008). The Performance of Robust Estimator on Linear Regression Model Having both Continuous and Categorical Variables with Heteroscedastic Errors, *Malaysian Journal of Mathematical Sciences*, 2(1): 25-48.
- Mitchell, B.R. (2003a) *International Historical Statistics: Africa, Asia & Oceania, 1750–2001*, 4th ed. (New York: Palgrave Macmillan).
- Mitchell, B.R. (2003b) *International Historical Statistics: Europe, 1750–2000*, 5th ed. (New York: Palgrave Macmillan).
- Mitchell, B.R. (2003c) *International Historical Statistics: The Americas 1750–2000*, 5th ed. (New York: Palgrave Macmillan).
- Parteka, A. (2007). Employment and export specialisation patterns versus GDP per capita performance: unifying approach. Quaderno di Ricerca (WorkingPaper), No 302, Università Politecnica delle Marche, Dipartimento di Economia Università'
- Parteka, A. and Tamberi M., (2008). "Determinants of export diversification: an empirical investigation". Quaderno di Ricerca (WorkingPaper), No. 327, Politecnica delle Marche, Dipartimento di Economia Università'
- Piñeres, S. and Ferrantino, M. (1997). "Export diversification and structural dynamics in the growth process: A case study of Chile." *Journal of Development Economics*, 52, 375–391.
- Potrafke, N. (2012). Intelligence and corruption. *Economics Letters*, 114, 109-112.
- Radelet, S. and Sachs, J. (1998). "Shipping Costs, Manufactured Exports, and Economic Growth." Draft paper presented at the American Economic Association meetings, (January).
- Ram, R. (2007). IQ and economic growth: Further augmentation of Mankiw-Romer-Weil model. *Economics Letters*, 94, 7-11.
- Rindermann, H. (2007a). Intelligence, cognitive abilities, human capital, and rationality at different levels. *Psychologische Rundschau*, 58(2), 137-145.
- Rindermann, H. (2007b). The g-factor of international cognitive ability comparisons: The homogeneity of results in PISA, TIMSS, PIRLS and IQ-tests across nations. *European Journal of Personality*, 21, 667-706.
- Rindermann, H., Kodila-Tedika, O. & Christainsen, G. 2014. "Cognitive capital, governance, and the wealth of nations," MPRA Paper 57563, University Library of Munich, Germany.
- Sala-i-Martin, X., Doppelhofer, G. & Miller, R.I. (2004) Determinants of long-term growth: a Bayesian averaging of classical estimates (BACE) approach. *American Economic Review* 94: 813-835.
- Schneider, F., A. Buehn and C.E. Montenegro (2010) "Shadow economies all over the world: new estimates for 162 countries from 1999 to 2007," Policy Research Working Paper Series 5356, The World Bank.
- Suh, J., & Chen, D. H. C., (2007). "Korea as a Knowledge Economy. Evolutionary Process and Lessons Learned", Korea Development Institute, https://www.usp.ac.fj/worldbank2009/frame/Documents/Publications_regional/409300PAPER0KR101OFFICIAL0USE0ONLY1.pdf (Accessed: 18/10/2014).
- Tchamy, S. V., (2014). "The Role of Knowledge Economy in African Business", Master Thesis. HEC-Management School, University of Liège.
- Verardi, V. and C. Croux (2009). Robust regression in Stata. *The Stata Journal* 9: 439-453.
- Weede, E. & Kämpf, S. (2002). The impact of intelligence and institutional improvements on economic growth. *Kyklos*, 55, 361-380.
- Weldemicael, E. 2010, Determinants of Export Sophistication
- Yohai, V. J. (1987). High Breakdown-Point and High Efficiency Robust Estimates for Regression. *The Annals of Statistics*, 15: 642-656